

Ethanol Update and Brief Overview of TBA

- **Ewan Moffat, P.G., Environmental Health Specialist, Site Assessment and Mitigation**

Summary of 1st talk (EtOH)

- **Review of ethanol.**
- **Ethanol groundwater update.**

PROPERTY	Benzene	MtBE	Ethanol
Solubility (mg/l)	1,780	43,000	Miscible
Henry's Constant	0.22	0.02	0.000252
Log K _{oc} (Sorption)	1.6 - 2.3	1 - 1.1	0.2 - 1.3
Biodegradability	Good	Poor	Excellent
Vapor Pressure (mmHg)	95	245	49-56



Desirable property for remediation



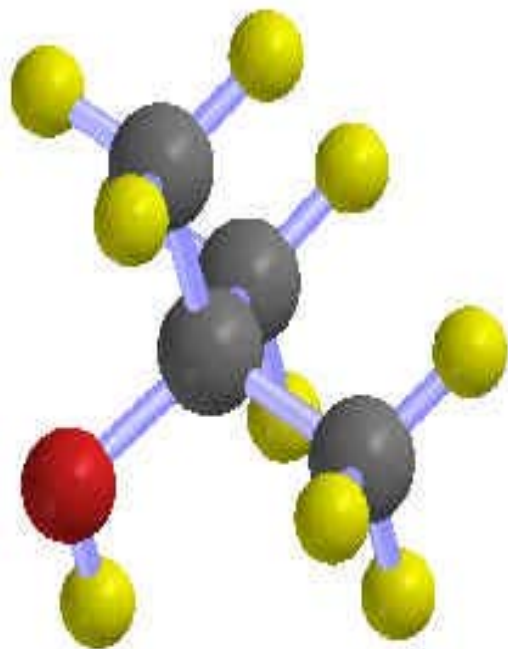
Undesirable property for remediation

EtOH update.

- **None detected in groundwater at this time in San Diego County.**
- **Biodegrades prior to sampling.**

Summary of 2nd talk (TBA)

- Chemical & physical properties
- Health impacts
- Where is the groundwater TBA coming from?
- Remediation of TBA
- Clean up standards.



T-Butyl Alcohol

- Molecular Weight – 74.12
- Melting point – 26°C (79°F)
- Boiling point – 82°C (180°F)
- Specific gravity – 0.78



Uses of T-Butyl Alcohol –

- Denaturant in ethanol (motor fuel in Brazil)
- Solvent
- Pharmaceutical industry (extraction)
- Musks

EtOH vs. TBA (observed data)

■ **EtOH:** Gone prior to sampling:-

Biodegradable

■ **TBA:** Persists:-

Not very biodegradable

	Benzene	MtBE	EtOH	TBA
PROPERTY				
Solubility (mg/l)	1,780	43,000	Miscible	Miscible
Henry's Constant	0.22	0.02	0.000252	0.00053
Log K _{oc} (Sorption)	1.6 - 2.3	1.0 – 1.1	0.2 – 1.2	1.5 – 1.8
Biodegradability	Good	Poor	Excellent	Poor
Vapor Pressure (mm Hg)	95	245	49 – 56	40 -42

 *Desirable property for remediation*

 *Undesirable property for remediation*

Biodegradability of TBA.

- Anaerobic.

- ◆ Degrades **slower** than MtBE

- Aerobic.

- ◆ Degrades **faster** than MtBE

	Benzene	MtBE	EtOH	TBA
PROPERTY				
Solubility (mg/l)	1,780	43,000	Miscible	Miscible
Henry's Constant	0.22	0.02	0.000252	0.00053
Log K _{oc} (Sorption)	1.6 - 2.3	1.0 – 1.1	0.2 – 1.2	1.5 – 1.8
Biodegradability	Good	Poor	Excellent	Poor Fair*
Vapor Pressure (mm Hg)	95	245	49 – 56	40 -42

*** Aerobic
Conditions**

HEALTH IMPACTS

- Carcinogen?
- Toxicity

TBA is *not* considered to be a carcinogen at this time.

- Conversion to **Formaldehyde** (carcinogen) in body:
- TBA: *(Remotely) Potential carcinogen.*

Toxicity of TBA.

- LD50 MtBE - 4000 mg / kg
- LD50 TBA - 3500 mg / kg

Taste Threshold in Water

- MtBE - 5 – 40 ug/l
(average **20 ug/l**)

- TBA – **21,000 ug/l**

- 1000 X more TBA to detect

Where does TBA come from?

- TBA as added oxygenate:
 - Sporadic (excess from refining process)
 - Oxinol-50: TBA Blend
 - ◆ 4.75% TBA / 4.75 % MeOH

Used long ago mostly on east coast. NOT a likely a likely scenario for the TBA found today in California.

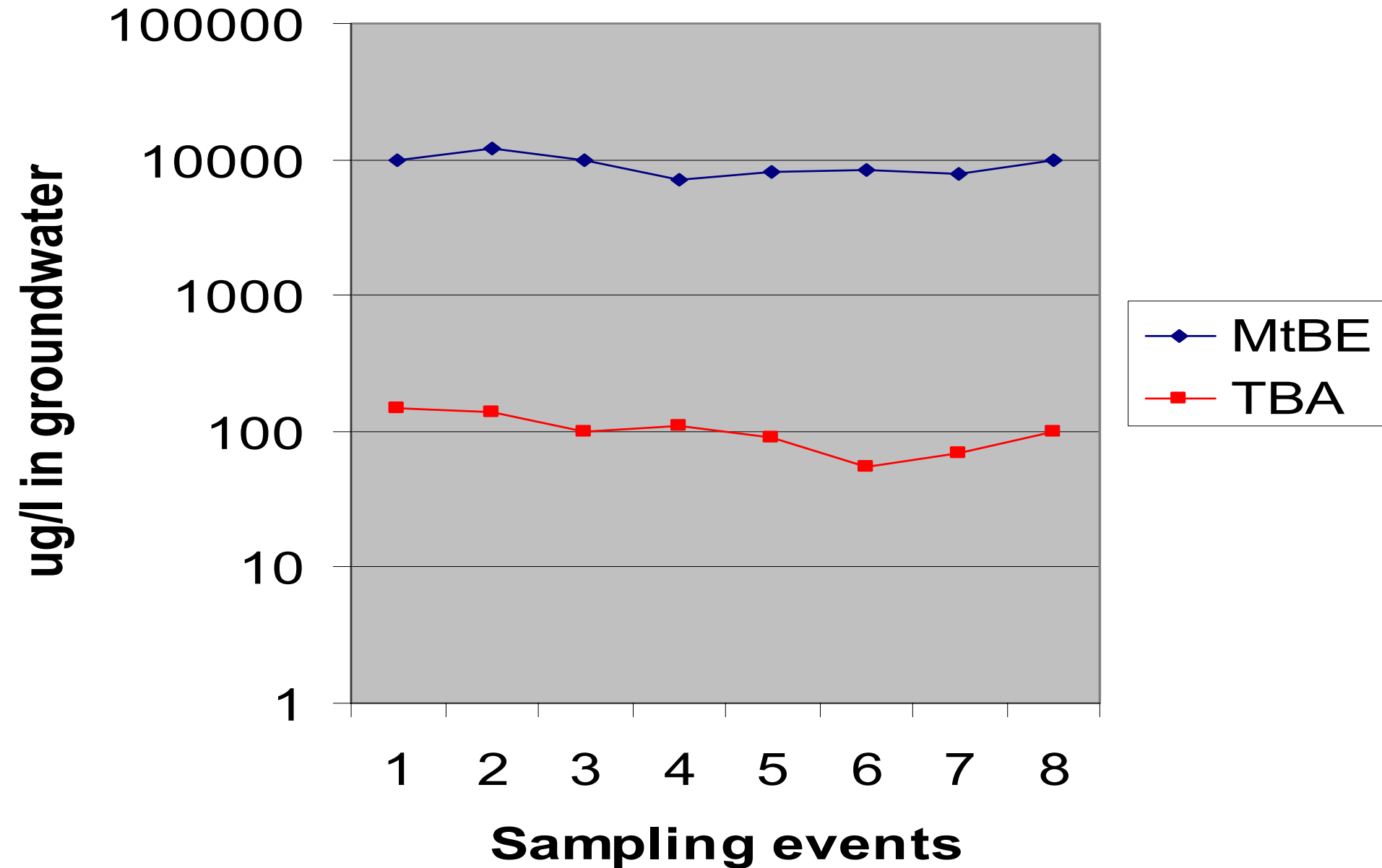
Where does TBA come from?

- Impurity added with MtBE:

- **TBA** ($\sim 1\%$)

Can account for a small amount of the TBA found now, but not all.

TBA vs MtBE over time



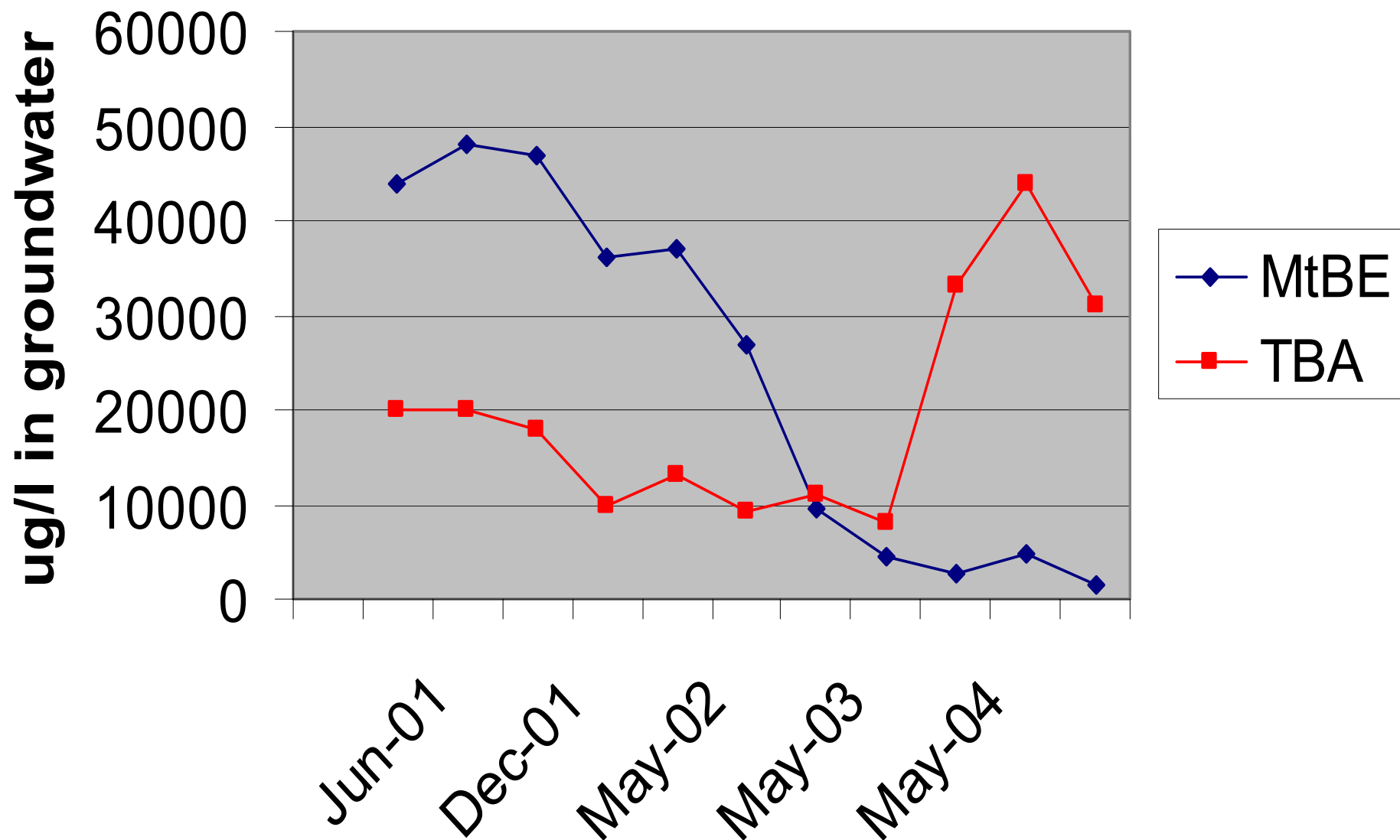
Where does TBA come from?

- Degradation product of MtBE:

- Anaerobic: $\text{MtBE} \rightarrow \text{TBA}$

Widely accepted as the source of the most of the TBA found now.

TBA vs. MtBE levels in MW-1



MtBE → TBA

- BTEX degraded first, Oxygen depleted
 - ◆ Anaerobic conditions.
- MtBE → TBA

Most effective Remediation of TBA

	Benzene	MtBE	EtOH	TBA
PROPERTY				
Solubility (mg/l) <i>*Air Strip / Sparge</i>	1,780	43,000	Miscible	Miscible
Henry's Constant <i>*Air Strip / Sparge</i>	0.22	0.02	0.00025	0.00053
Log K _{oc} <i>*Carbon</i>	1.6 - 2.3	1.0 – 1.1	0.2 – 1.2	1.5 – 1.8
Vapor Pressure <i>*SVE (Vadose)</i>	73	240	41	44
Biodegradability	Good	Poor	Excellent	Fair * Poor

*** Aerobic
Conditions**

What Works??

-Currently in use

- Combination of two
 - ◆ **Air Strip + GAC, etc.**
- BTEX, oxygenates (+ TBA)

What Works??

TBA-Specific systems

- Oxidation (Peroxides, Ozone, etc.)
- Oxidation / UV light.
- Resin adsorbents
- Bio-Filters
- Activated sludge
- Natural attenuation, aerobic conditions.



Action / Cleanup levels.

- California - 12 ug /l
- Maryland – 25 ug /l
- New York – 50 ug/l
- Connecticut & New Jersey – 100 ug /l
- Missouri – 104 ug/l
- Florida – 1,500 ug /l
- Texas – 2,200 ug /l
- Wyoming – 3,200 ug/l
- Michigan – 3,900 ug/l

TBA and DEH directives.

- At this time, *no* new directives
- As always,
 - ◆ Assess and evaluate risks.

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Site Assessment and Mitigation

ewan.moffat@sdcounty.ca.gov

(619) 338-2212